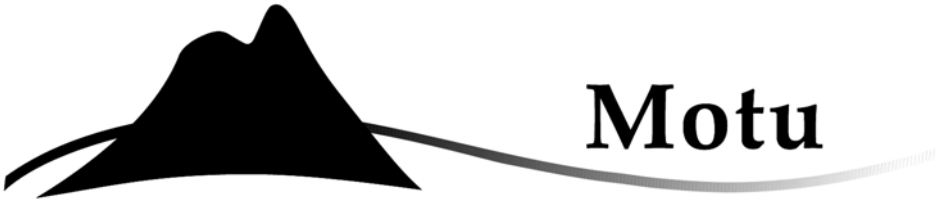

The Ups and Downs of New Zealand House Prices

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Abstract

This paper identifies the expansion and contraction phases of New Zealand's national and regional house prices, by employing techniques typically used to study cycles in real activity, the so-called Classical cycle dating method. We then enquire into the nature of the cycles, addressing five questions: (1) What are the New Zealand and regional house price cycles, and do the regional cycles differ from the national cycle?; (2) What are the typical durations, magnitudes and shapes of these house price cycles?; (3) Do cycles in house prices match cycles in economic activity, at either national or regional levels?; (4) Does it matter which of the two main sets of house price series are used? i.e. Quotable Value New Zealand (QVNZ) or Real Estate Institute of New Zealand (REINZ)?; and (5) Does the sample period matter? Findings are evaluated in the context of work by Grimes, Aitken and Kerr (2004), and Hall and McDermott (2005). Avenues for further research are suggested.

JEL classification
C22, E31, E32, R11, R15, R21

Keywords
House price cycles; regional business cycles; classical business cycle; New Zealand.

Contents

1 Introduction

The housing market is an important part of the economy, and discussions of the ups and downs of house prices are again popular (International Monetary Fund, 2003 and 2004). However, exactly what constitutes a housing market up or down is seldom made specific. An overarching aim of this paper, therefore, is to formally identify when expansion phases for real house price movements turn into contraction phases, and *vice versa*[1]. We do this by employing techniques typically used to study cycles in real economic activity – the so called classical cycle dating method. This dating method has been employed productively in empirical research into other asset markets, including equity prices (Pagan and Sossounov, 2003) and commodity prices (Cashin, McDermott and Scott, 2002). It would also seem a more appropriate method for dating house price turning points than a growth cycle approach, as house purchasers and sellers are often more focussed on changes in direction of the house price level than its rate of growth.

Once the turning points of New Zealand's national and regional house price cycles are determined we can enquire into the nature of the cycles. Five important questions are addressed: (1) What are the New Zealand and regional house price cycles, and do the regional cycles differ from the national cycle?; (2) What are the typical durations, magnitudes and shapes of these house price cycles?; (3) Do cycles in house prices match cycles in economic activity, at either national or regional levels?; (4) Does it matter which of the two main sets of house price series are used? i.e. Quotable Value New Zealand (QVNZ) or Real Estate Institute of New Zealand (REINZ)?; and (5) Does the sample period matter?

The paper should also be seen in the context of conclusions from two previous pieces of work in the area. In Grimes, Aitken and Kerr (2004), from OLS and SUR regressions of panel data, for 14 economic regions over the period 1981q1 to 2002q4, it was concluded that for long run New Zealand a 1 percent increase in

1 Our classification is therefore less restrictive than that used in the IMF's (2003) investigation of asset price booms and busts for 19 industrial countries in the postwar period. They define house price booms as large and persistent increases, which begin with a peak and end with the subsequent peak, i.e. the boom is over the full P-T-P cycle. Correspondingly, house price busts (termed crashes in the case of equity prices) are large and persistent decreases, with the busts (crashes) having to exceed 14 percent (37 percent). Busts begin one quarter after a peak, and end with the relevant trough quarter.

regional economic activity would lead to real house prices increasing between 0.9 and 1.2 percent. From the same long run equations, a 1 percentage point increase in the expected real user cost of capital would lead to real house prices falling between three-quarters of one percent and one percent; and a 1 percent increase in the housing stock to a fall of around two-thirds of one percent[2]. Somewhat in contrast, though, in a bivariate cyclical dynamics context for the longer period of 1975q1 to 2002q1, Hall and McDermott (2005) could find no statistically significant associations between national or regional economic activity cycles, and either national or Auckland real house price cycles[3]. Taken at face value, these two sets of conclusions could seem contradictory. But it is also possible that, once due account is taken of the different sample periods, data sets and equation specifications, and the differing degrees of emphasis they put on short run cyclical dynamics and on long run behaviour, some of the results from this study may assist in narrowing the potential differences, and hence the implications for aggregate demand management policies.

This paper is set out as follows. The data are described in Section 2. Section 3 provides some salient features of QVNZ house price series. Section 4 specifies what we mean by the ups and downs of house price movements and describes how these are dated. Several non-parametric methods are used to examine the nature of the house price cycles identified, and concordance statistic results are presented to establish the extent of bivariate linkages between economic activity and house price cycles. Section 5 evaluates the implications of our results.

2 Data

Our quarterly real house price series are for New Zealand and 14 regional areas. The regions are: Northland, Auckland, Waikato, Bay of Plenty, Gisborne, Hawke's Bay, Taranaki, Manawatu-Wanganui, Wellington, Tasman-Nelson-Marlborough, West Coast, Canterbury, Otago, and Southland.

[2] Grimes, Aitken and Kerr (2004, p 18) also conclude that the long-run upward trend in house prices in most regions can be associated primarily with increases in economic activity and to the effects of tastes and other factors proxied by time trend variables, as the real user cost of capital has not changed markedly over long periods.

[3] As emphasised in Rosborough (2005, p2), the most severe decline in house prices since the early 1960s occurred in the mid-1970s. See also Figure 1.

The QVNZ national and regional house price series used in this study were provided by Motu Economic and Public Policy Research. The series represent the median sales of owner-occupied dwellings in the residential housing market, and therefore exclude multi-unit residential sales and all non-residential transactions. Territorial Local Authority (TLA) level data are aggregated to Regional Council (RC) level, and Motu document[4] the extent of their smoothing adjustments, to eliminate extreme movements. This occurred primarily for areas in which there were relatively few sales, and at the RC level this was necessary only for the West Coast and only for 7 quarterly observations.

The REINZ indexes are based on the median value of properties sold in a region in the reference period. A sale is deemed to have occurred when the property goes unconditional. The statistical information report by REINZ has wide coverage but may not be complete since it is compiled from reports of sales made through Real Estate Agents only. Both the QVNZ series and the REINZ indexes have been deflated using the CPI excluding interest costs, 1999q2 base =1000.

The national and regional activity data are from the National Bank of New Zealand (NBNZ). Twenty-three series are used to calculate the composite indices or regional economic activity, including: business confidence; consumer confidence; retail sales; new motor vehicle registrations; regional exports; registered unemployment; building permits approved; real estate turnover; household labour force data; job ads; and accommodation survey data. The data are reported on a seasonal and inflation adjusted basis. The NBNZ activity series are available quarterly from 1975q1 to 2004q2, as are the REINZ house price indexes; the QVNZ series date from 1981q1 (Figure 1).

3 Characteristics of house prices across the regions

It is important to review salient features of our series for real house price levels, prior to examining their cycles. Table 1 therefore summarizes key facts for

[4] See Grimes, Kerr and Aitken (2003, section 4).

QVNZ national and 14 regional house price series, over the period, 1981q1 to 2004q2 before any transformations of the data are considered[5].

Most of the series exhibit upwards trends, although Gisborne and Southland are notable exceptions. The series have very high first-order autocorrelation coefficients even after the series have been detrended, i.e. are non-stationary. The autocorrelation coefficients based on an annual autoregressive (AR) model are lower but still substantial. The persistence measure in the third column is measured by the half-life of innovations, that is the length of time (number of years) until the impulse response of a unit shock is half its original magnitude. Most of these numbers are very large, if not infinite, so that the general picture is one where real house price levels tend to revert only very slowly to a deterministic trend, if at all. This salient feature observed at the regional level, is also present in the national index.

The coefficients of variation show the Auckland region's price levels to have varied the most, but there is a large amount of quarter to quarter variability in most regions. Manawatu-Wanganui has relatively low quarter to quarter variability but a plot of the series reveals relatively large swings in its cycle. There is substantial skewness in house prices reflecting the relative upwards drift in house prices. West Coast is an exception here; although its real house price has trended up, West Coast prices have been vulnerable to sharp downward spikes. West Coast prices also exhibit substantial kurtosis, with tails much thicker than those of the normal distribution, a feature that appears for several other regions. The widespread kurtosis indicates that large price movements are relatively common. Finally, the persistence of price level variability suggests there is clustering of large or small variances lasting 1 to 3 years in the rural regions while the urban dominated regions tend to have permanent change to their regimes. These characteristics are consistent with their being considerably fewer sales for the smaller regions relative to the larger ones, as manifested particularly in the data for the West Coast region.

Overall, our price levels data display a high degree of autocorrelation (possibly even unit root behaviour), substantial variability, some skewness, and

[5] A similar Table could be presented for the REINZ series. The period from 1981q1 is chosen to illustrate the salient features, as a full set of QVNZ regional house prices is not available prior to that quarter.

kurtosis. Such characteristics present difficulties for the time series methods, that are most often used to model these prices. Rather than engage in building potentially complex parametric models of real house prices, we choose to deal with the data in levels using nonparametric methods. That is, the measure of the cycle we will be using is the classical cycle rather than the growth cycle. One advantage is that we can avoid the somewhat subjective choice of which detrending method to use required for the growth cycle methods.[6]

4 Housing Cycles

4.1 Dating the Peaks and Troughs, and establishing the national and regional cycles

The method we use to date the cycles in house prices is the pattern-recognition algorithm initially provided by Bry and Boschan (1971). The algorithm operates in a sequence of passes through the data. On the first main pass, the location of potential peaks and troughs are identified by searching through groups of windows $\{y_{t\pm k}\}$, k=1,…,K and examining each group for local peak or troughs. The second main pass enforces a condition that peaks and troughs must alternate. The third imposes a minimum length for an expansion phase (up) or a contraction phase (down). There are other passes that smooth the data to remove the influences of outliers and to determine how the end points are to be treated. For further details on the Bry-Boschan method, see King and Plosser (1994), Watson (1994), Harding and Pagan (2002, 2003), and in a New Zealand context Kim, Buckle and Hall (1995) and Hall and McDermott (2005).

Figure 2 shows the results of applying the Bry-Boschan algorithm to QVNZ house prices for New Zealand's 14 regions and New Zealand. The solid vertical lines indicate peaks while dotted vertical lines indicate troughs. The equivalent peaks and troughs, and expansions and contractions for real REINZ house prices appear in Figure 3.

[6] Canova (1998) discusses some of the potential distortions introduced to the measurement of growth cycles by commonly used detrending methods.

Visual inspection of the plots reveals the asymmetric nature of the price cycles. Just like cycles in economic activity, upswings are generally longer than downswings.

Tables 2 and 3 report the specific quarters in which the peaks and troughs of the housing price cycles occur. Visual inspection of these confirms that house price cycles vary substantially across regions, and that in many cases they have behaved very differently from the corresponding national cycle. In short, it will be important to establish more precisely the extent to which the regional cycles differ from the national cycle.

The different turning points also bring into focus the issue of which set of series to use and whether the differences are material. The proportion of time regional house prices from the two sources are in the same phase of the cycle (expansion or contraction), and hence of how closely the two indices move together, can be measured by concordance statistics.

Harding and Pagan (2002) introduced a simple non-parametric statistic to measure concordance. This statistic describes the proportion of time two series x_i and x_j, are in the same phase. Specifically, let $\{S_{i,t}\}$ be a series taking the value one when the series x_i is in an expansion phase, and zero when it is in a contraction phase; and let $\{S_{j,t}\}$ be a series taking the value one when the series x_j is in expansion, and zero when it is in contraction. The degree of concordance is then:

$$C_{ij} = T^{-1}\left\{\sum_{t=1}^{T}\left(S_{i,t}\cdot S_{j,t}\right)+\sum_{t=1}^{T}\left(1-S_{i,t}\right)\left(1-S_{j,t}\right)\right\}$$

where T is the sample size and C_{ij} measures the proportion of time the two series of interest are in the same phase.

For most regions, concordance between QVNZ and REINZ series is relatively high and significant, and contemporaneous concordances are the predominant ones. (Table 4). However, this is not uniformly the case[7]. In particular, contemporaneous Concordance statistics are not significant for aggregate New Zealand, nor for the bigger regions of Auckland and Canterbury (and its adjacent Nelson-Marlborough and West Coast regions). Consequently, some results from our analysis could be affected by which set of house price series is used. At this stage, we will continue to present both QVNZ and REINZ results.

4.2 The nature of house price cycles

Armed with the dates of the peaks and troughs determined for the QVNZ and REINZ data, we can examine the nature of the cycles. First we report on the features of movements in house prices between the turning points (Tables 5 and 6). For each region the tables split the data into two phases – expansion or contraction. For each phase, we present results for: the average duration (in quarters) of the phase and the average amplitude (in total and rate per quarter) of the phase movement in prices (in percent change).

As is well-known for cycles in economic activity, there is evidence here of asymmetry in house price cycles – price rise phases being longer than decline phases. Averaging across all regions, the duration of price expansions is just under 3 years while contractions seem to last about 1½ years on average, giving an average cycle (peak-to-peak) of about 4 to 4½ years.

The speed with which house prices change in expansion relative to contraction phases, can be determined by examining relative quarterly amplitudes. Averaging across all regions, the average quarterly percent moves are roughly equal for both the up and down phases.

[7] Material exceptions are: for Northland, QVNZ turning points lead those from the REINZ series by 3 quarters, with concordance increasing from 74 to 80 percent; for Canterbury, REINZ turning points lead QVNZ turning points by 2 quarters, with concordance 74% instead of 66%. Both regions have had relatively few expansion and contraction phases (3 and 4, and 2 and 3 respectively), so the greater significance of these non-contemporaneous concordances may not be sustained over increased numbers of cycles.

We also examine whether there is any tendency for the ups and downs of New Zealand house prices and those in the individual regions to maintain a fixed duration. That is, is there duration dependence in house price cycles, in the sense that the probability of switching between phases increases, the longer that prices have been in a given phase?

The duration dependence hypothesis can be tested using the Brain-Shapiro test, the results of which are shown in Tables 7 and 8. The null hypothesis that the probability of terminating a phase is independent of the length of time prices have been in a phase, whether in up or down phase, cannot be rejected for New Zealand, nor for any region.

The Spearman rank correlation coefficient is used to measure whether there is any relationship between the severity of price rises and their duration, and the severity of price falls and their duration. Basically we are testing for a significant association between the amplitude of phase and its corresponding duration. The null hypothesis is that there is no rank correlation between the amplitude of an expansionary (contraction) phase and its duration. For New Zealand, it is not clear whether either expansions or contractions are similar in shape. This is because, for NZ time series data, there is no similarity in shape for QVNZ data and no usable result for REINZ indexes. Yet for the "All Phases" panel data sets, there is similarity in shape for both QVNZ expansions and contractions, and similarity in shape for REINZ expansions but not contractions. For regions, there is considerable variation as to uniformity of shape. Expansion shapes are similar more often than for contractions, but the regions in each category vary by data set. So, the shapes of many phases look broadly similar, but the relatively small number of cycles within our sample makes it difficult to formally confirm this.

4.3 The link between house prices and business activity

The next issue to examine is whether house price cycles move in line with national or regional business cycles, and whether the regional house price rises (falls) occur at the same time as regional economic expansions (contractions), or lag the activity cycles. It is also possible, of course, that house price cycles could lead rather than lag regional or national economic activity, for example because house prices

movements could be forward looking. However, perhaps surprisingly, we could find no statistically significant evidence for any region or for New Zealand, of either QVNZ or REINZ house prices leading economic activity.

Accordingly, the concordance statistics and significance test results presented in Tables 9 to 12, are solely those for contemporaneous relationships, and for regional and national economic activity cycles leading QVNZ and REINZ house price cycles by up to 12 quarters.

Overall, these results provide somewhat greater evidence of real economic activity driving real house price cycles procyclicly, than that found in Hall and McDermott's (2005) preliminary work[8]. But the evidence is far from consistent across regions.

Before commenting on specific associations, it is prudent to acknowledge that we are considering relatively limited numbers of completed cycles, e.g. 4 for New Zealand and Wellington, 5 for Auckland and Southland, 6 for Waikato and Gisborne, and only 3 for Canterbury. Recall also the cautionary comment made in section 3 above, that a greater number of cycles for smaller regions such as the West Coast might simply reflect their considerably fewer sales. This could mean either that the larger number of cycles results from data mis-measurement of the region's "true" mix-adjusted house prices, or that it reflects the median sales price of a smaller region being less smooth than that of a large region[9].

For cycles at the national level, the strongest concordances are at lags of 8 quarters (QVNZ) and 10 quarters (REINZ), and for QVNZ data there are no statistically significant contemporaneous or short lagged concordances. This seems consistent with quite diverse behaviour across regions, and with some of the house price cycles either reacting with considerable lags to national economic activity or being primarily driven by regional economic activity.

[8] Recall that Hall and McDermott used QVNZ real house price data for New Zealand and Auckland only, for the longer sample period from 1975q1 which included the significant decline in real house prices from the mid-1970s

[9] We thank Arthur Grimes for suggesting these additional cautions.

The results for regions are quite diverse: (1) Perhaps surprisingly, no region's house price cycles have been driven solely by national economic activity, either contemporaneously or with lags of up to 3 years; (2) For a considerable number of regions, there are no significant associations either with their own economic activity or national activity, at the 1 percent level. While this outcome is somewhat sensitive to data set, it is generally the case for smaller regions such as Northland, Gisborne, Manawatu-Wanganui, West Coast, and Southland. For Wellington and Canterbury, there don't seem to be robustly consistent results; (3) There are some regions whose house price cycles seem influenced primarily by regional rather than national economic activity, in some cases contemporaneously and in others with considerable lag. Again, there is some sensitivity to data set. Most noticeably in this category are: (i) Auckland, with QVNZ house price cycles driven contemporaneously by Auckland regional activity; (ii) Waikato and Bay of Plenty, whose QVNZ and REINZ house price cycles respond with lags of 8 to 10 quarters to their own regional activity (and a little more weakly to the equivalent period national activity); (iii) Hawkes Bay, Taranaki, and Otago QVNZ (but not REINZ) house prices responding contemporaneously to their regional activity, Northland responding somewhat less significantly to their own economic activity, and Gisborne's QVNZ house prices even less so.

4.4 QVNZ or REINZ house price movements? Does the sample period matter?

The evidence presented above in Table 4, and Tables 9 to 12 in particular, is consistent with results differing somewhat by QVNZ or REINZ series. It is also clear from Figure 1, that care needs to be taken with choice of sample period. That visual evidence is confirmed by the somewhat contrasting results obtained in this paper and that of Hall and McDermott (2005), for associations of Auckland and New Zealand house price cycles with economic activity cycles.

5 Conclusions

Classical business cycle dating methods have been used to identity turning points for national and regional New Zealand real house prices over the period

1981q1 to 2004q2. It has also been established that regional house price cycles differ considerably from the national cycle.

On the second question, that of typical durations, amplitudes and shapes, the average New Zealand peak-to-peak cycle has been around 4.5 years. This reflects an average expansion phase of nearly 3 years and average contraction phase of about 1.5 years. The average duration and amplitude have been asymmetric, and as has been found previously for aggregate real economic activity, real New Zealand house price cycles do not die of old age[10]. The evidence is not yet clear whether either expansions or contractions have been similar in shape for New Zealand. A somewhat cautionary note is that there have been relatively few cycles over the period, just greater than the number of cycles in economic activity. As expected, successive individual cycles have not been identical.

House price cycles differ considerably across the 14 regions, with average expansion phases varying between 5 and 23 quarters, and average contractions between 3 and 9 quarters. It is also the case that many average regional cycle phases differ materially from the average New Zealand cycle. Conventional asymmetry of duration does not hold for all, and in particular Southland has displayed longer and deeper contractions than expansions (for both data sets). The relatively small West Coast region has exhibited not only the greatest number of expansions and contractions (8 for both), but also the steepest expansions and contractions per quarter. For all regions (both data sets), expansions and contractions do not die of old age. But on uniformity of shape, regional expansion shapes are similar more often than those for contractions.

The third major issue was whether cycles in house prices have been synchronised with cycles in economic activity. Complementary questions here were whether dynamic results might be inconsistent with previously established long run associations, and the extent to which conclusions could differ by data set and/or sample period.

[10] See Hall and McDermott (2005), and Hall, McDermott and Rosborough (2005)

We find somewhat greater evidence of real economic activity driving real house price cycles procyclicly, than that found in Hall and McDermott's (2005) preliminary work using New Zealand and Auckland house prices for the longer period back to 1975q1. But the evidence is far from consistent across regions. The differences seem attributable in the cases of New Zealand and Auckland, at least as much to the sample period being from 1981q1 instead of 1975q1, and for some regions are dependent on the data set used. In short, in relation to the fourth and fifth questions, the sample period is particularly important, it also matters which region is being considered, and in some cases the data set can also make a difference.

Hence, at this point, we have shed further light in a univariate and bivariate sense on the cyclical behaviour of national and regional house price and economic activity movements. The logically next stage is to carry out multivariate work. This would complement the long-run and dynamic adjustment process work reported in Grimes, Aitken and Kerr (2004) referred to in our Introduction, and in which regional economic activity, the expected real user cost of capital, the regional housing stock, and an asymmetric influence of regional house sales activity were all found significant.

We expect one avenue for this further work will involve an unobserved components analysis of the possibility of establishing a common New Zealand real house price cycle, and the extent to which regional cycles and spillover effects are material or not (e.g. Kouparitsas, 2002; and Norman and Walker, 2004). If a common cycle is shown to dominate regional and spillover effects, then specific drivers of the common cycle (such as monetary policy, fiscal policy, and external shocks) should be investigated. A second avenue will utilise a growth cycle regression approach.

6 Figures

Figure 1. Real House Prices and Economic Activity New Zealand, 1975q2 (&1981q1) to 2004q2

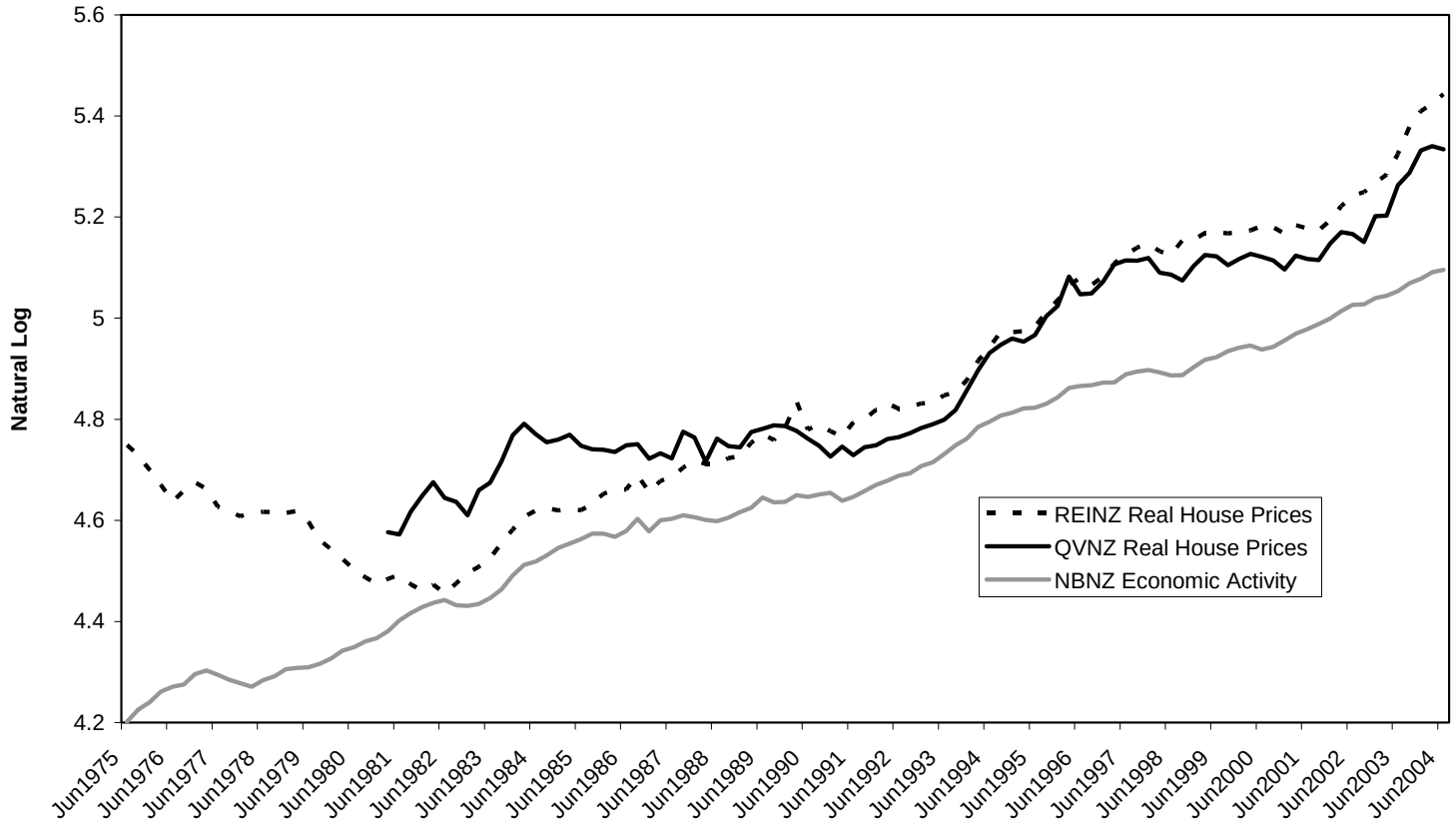
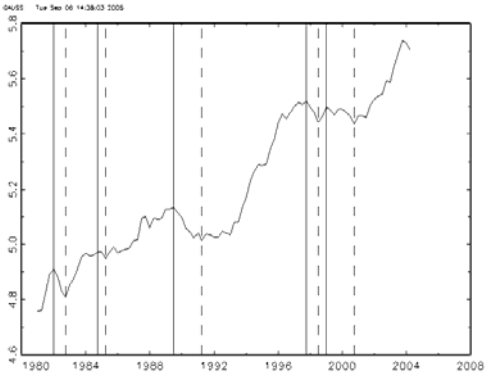
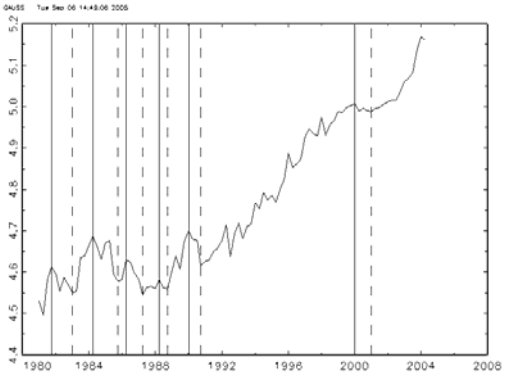


Figure 2. QVNZ Real House Price Cycles (natural log scale)

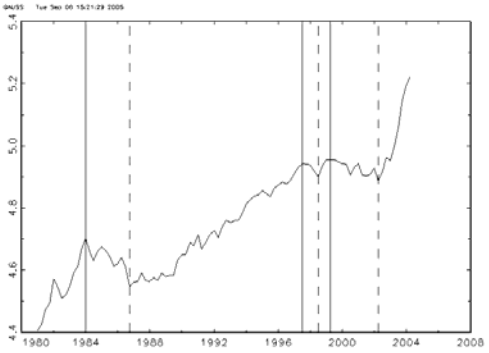
Auckland (84% concordant with NZ)



Waikato (84% concordant with NZ)



Canterbury (81% concordant)



Bay of Plenty (84% concordant)

New Zealand

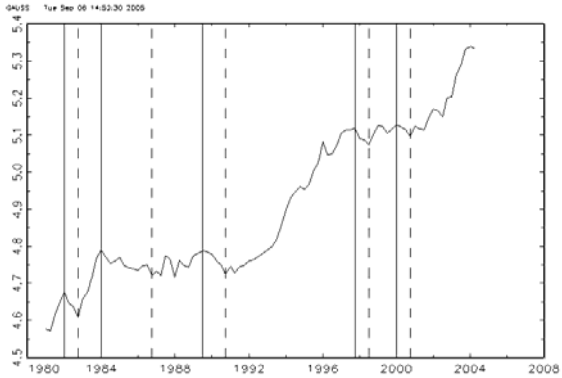
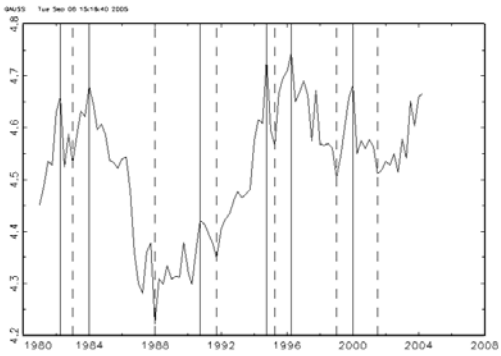


Figure 2. (continued)

Northland (74% concordant)

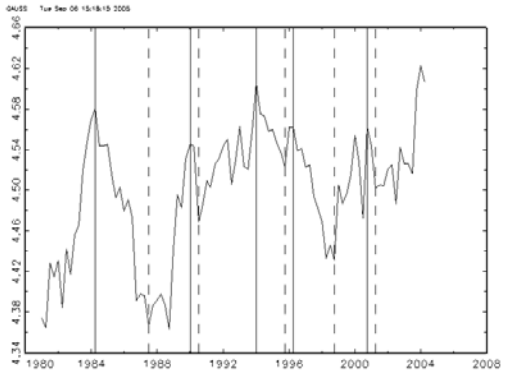
Gisborne (69% concordant)



Hawke's Bay (70% concordant)

Taranaki (68% concordant)

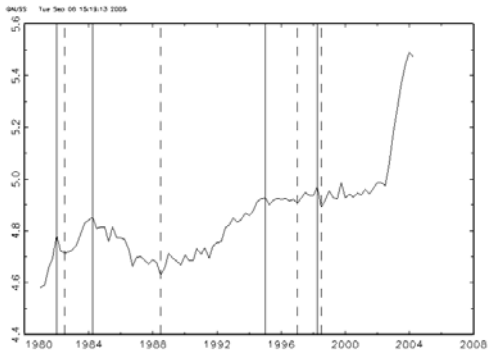
Manawatu-Wanganui (69% concordant)



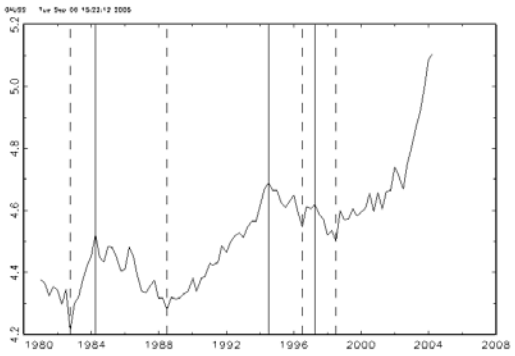
Wellington (67% concordant)

Figure 2. (concluded)

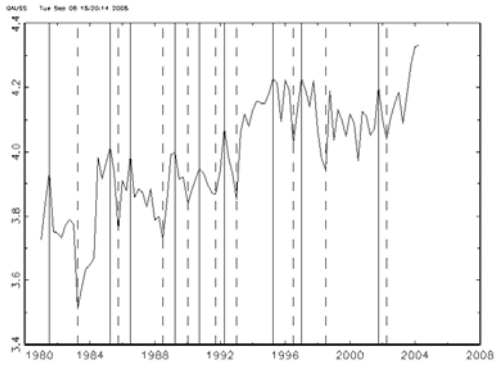
Nelson-Marlborough (71% concordant)



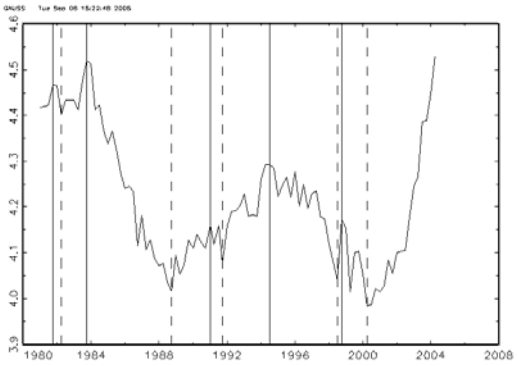
Otago (67% concordant)



West Coast (54% concordant)



Southland (57% concordant)



New Zealand

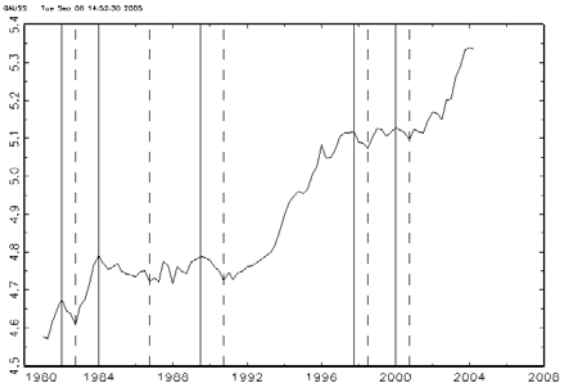
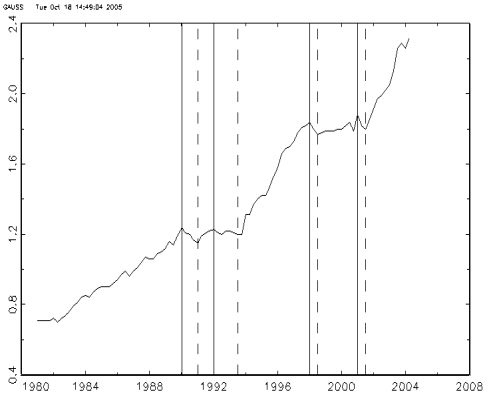
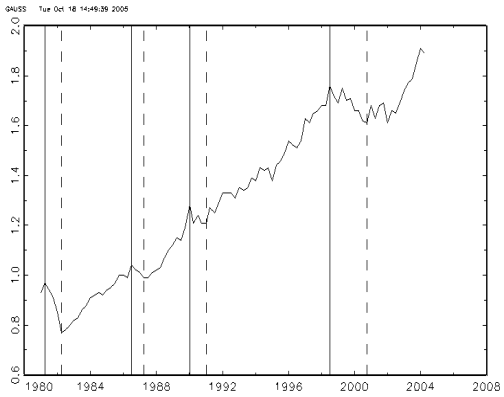


Figure 3. REINZ Real House Price Cycles

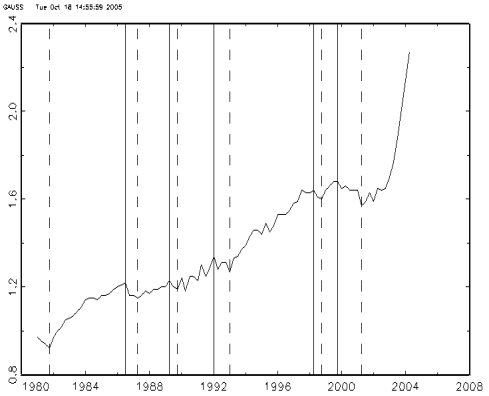
Auckland (81% concordant with NZ)



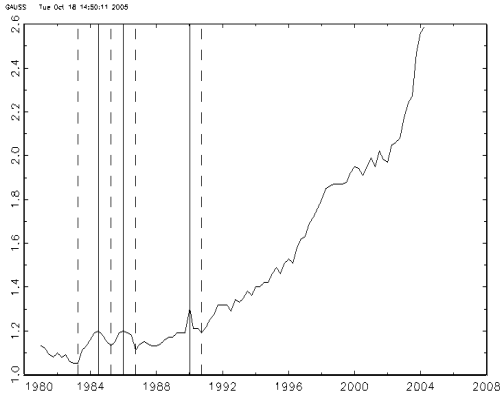
Waikato (87% concordant with NZ)



Canterbury (78% concordant)



Bay of Plenty (86% concordant)



New Zealand

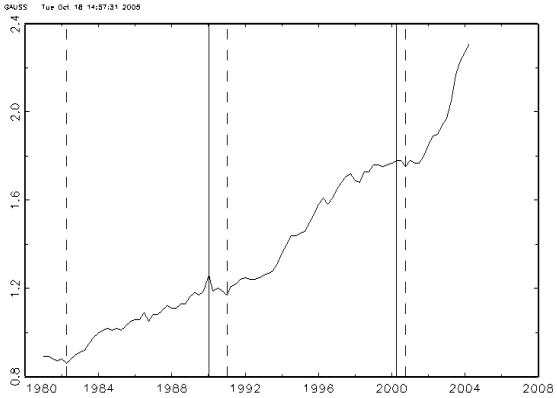
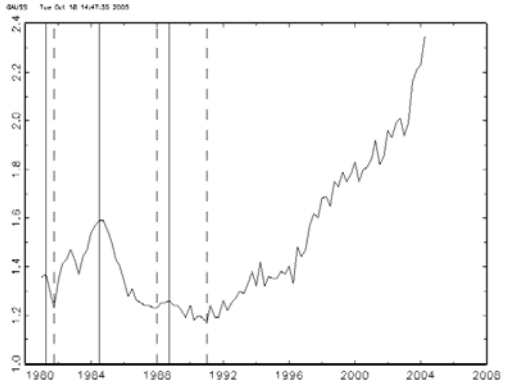
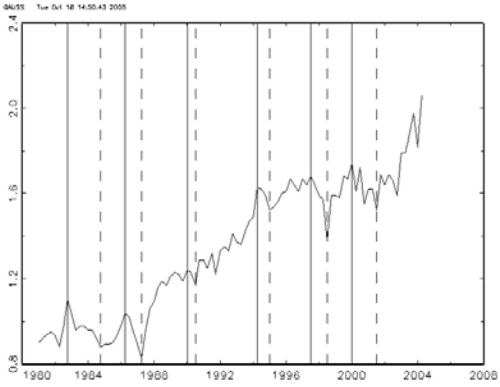


Figure 3. (continued)

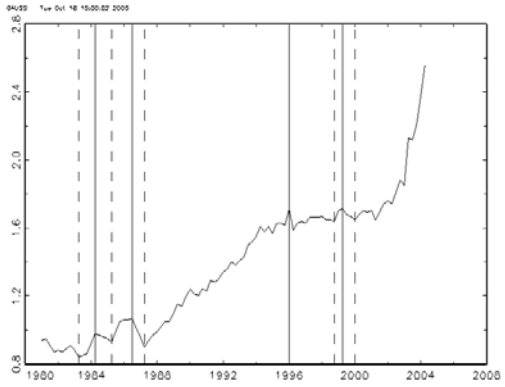
Northland (73% concordant)



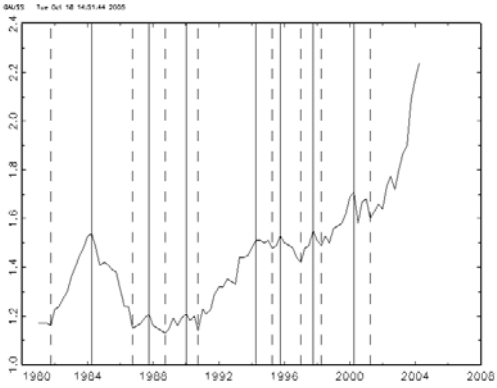
Gisborne (67% concordant)



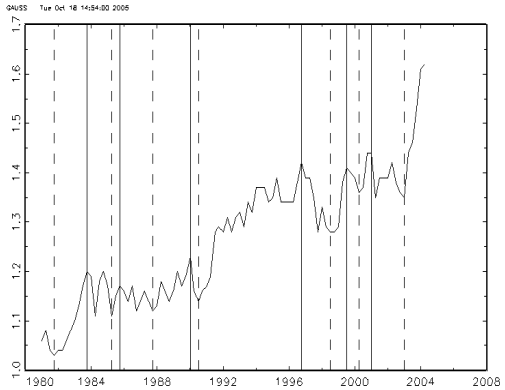
Hawke's Bay (67% concordant)



Taranaki (68% concordant)



Manawatu-Wanganui (60% concordant)



Wellington (82% concordant)

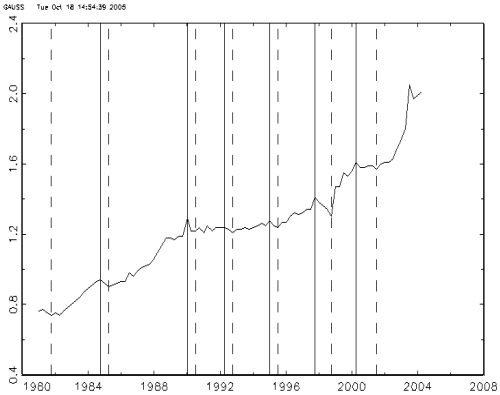
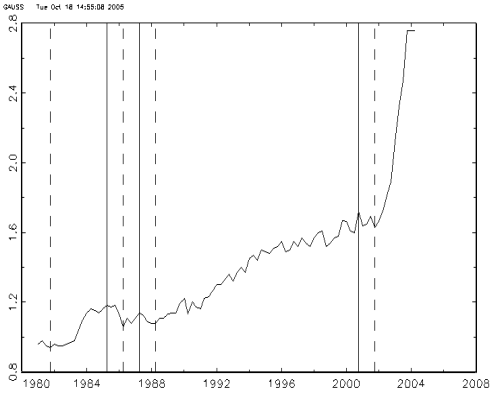
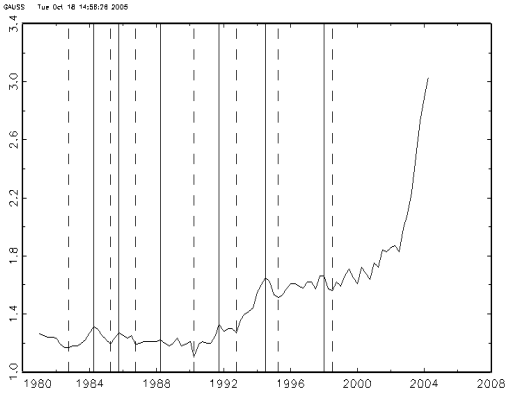


Figure 3. (concluded)

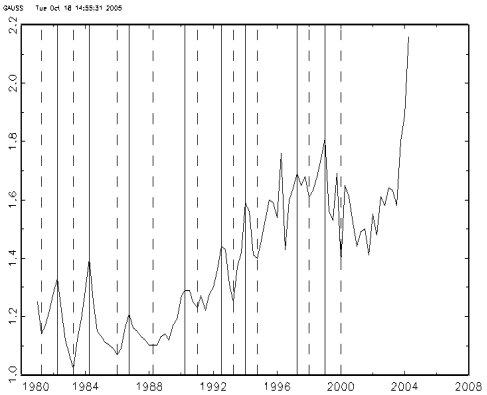
Nelson-Marlborough (79% concordant)



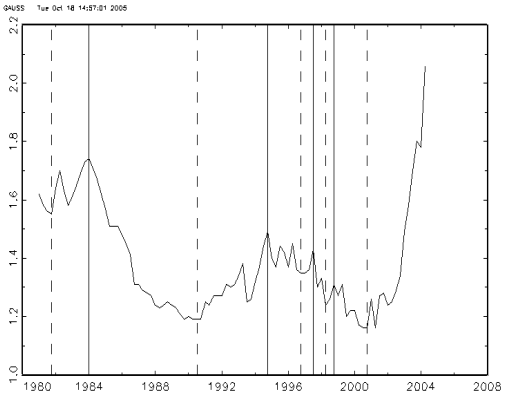
Otago (67% concordant)



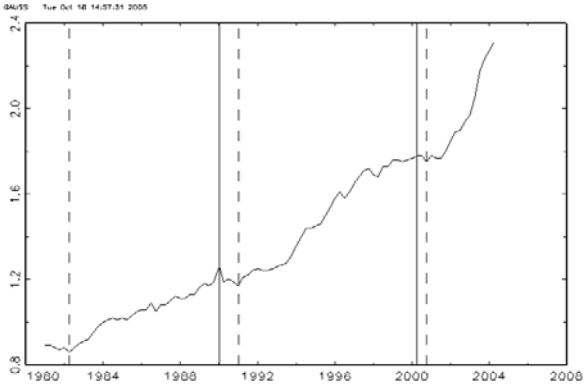
West Coast (61% concordant)



Southland (52% concordant)



New Zealand



7 Tables

Table 1. House Price Facts (QVNZ data), 1981q1-2004q2

Region	Autocorrelation Coefficient *(one quarter)*	Autocorrelation Coefficient *(one year)*	Persistence *(in years)*	Coefficient of Variation	Skewness	Kurtosis	Volatility Persistence *(in years)*
Northland	0.94	0.89	2.72	0.18	0.60	2.20	3.15
Auckland	0.97	0.79	5.10	0.27	0.53	2.04	inf
Waikato	0.94	0.83	2.60	0.19	0.63	2.09	2.19
Bay of Plenty	0.98	0.92	8.78	0.19	0.73	2.29	1.11
Gisborne	0.87	0.69	1.28	0.12	-0.27	2.27	1.93
Hawke's Bay	0.99	0.97	19.96	0.18	1.15	5.42	1.25
Taranaki	0.96	0.78	4.07	0.13	0.29	3.35	3.73
Manawatu-Wanganui	0.81	0.46	0.84	0.06	-0.46	2.55	0.17
Wellington	0.99	0.97	17.56	0.19	0.81	3.70	inf
Nelson-Marlborough	1.06	1.30	inf	0.21	2.36	9.65	3.22
West Coast	0.32	0.43	0.15	0.20	-1.31	8.38	0.87
Canterbury	1.01	0.62	inf	0.18	0.62	3.14	1.52
Otago	1.04	1.02	inf	0.19	1.69	7.04	inf
Southland	1.00	0.93	inf	0.15	0.69	2.45	2.69
New Zealand	0.98	0.87	31.22	0.21	0.63	2.24	18.48

Notes. The autocorrelation cofficients are estimated from the AR model $y_t = c + bt + ay_{t-k} + e_t$, for k=1 and 4. Persistence is measured by the half-life of innovations from the AR model with k=1; that is, ln(0.5)/ln(a). The coefficient of variation is the ratio of the standard deviation to the arithmetic mean. The skewness measure is $u_3/(u_2)^{1.5}$ and the kurtosis measure is $u_4/(u_2)^2$, where u_r denotes the r^{th} (central) moment. The skewness of a symmetrical distribution, such as the normal distribution, is zero: similarly, the kurtosis of the normal distribution is 3.

Table 2 Classical Turning Points for Cycles in QVNZ House Prices
NBER (Bry and Boschan) Method, 1981q1 to 2004q2

	ND	AK	WK	BP	GS	HB	TA	MW	WG	NM	WC	CA	OT	SD	NZ
P	1982(1)	1982(1)	1981(4)	1982(1)	1982(2)	1982(1)				1982(1)	1981(3)			1981(4)	1982(1)
T	1982(4)	1982(4)	1983(1)	1982(4)	1983(1)	1982(4)				1982(3)	1983(2)		1982(4)	1982(2)	1982(4)
P	1984(1)	1984(4)	1984(2)	1984(1)	1984(1)	1984(2)	1984(1)	1984(2)	1984(4)	1984(2)	1985(2)	1984(1)	1984(2)	1983(4)	1984(1)
T		1985(2)	1985(4)	1985(1)					1986(2)		1985(4)	1986(4)			1986(4)
P			1986(2)	1985(3)							1986(3)				
T	1988(2)		1987(2)	1988(3)	1988(1)	1988(3)	1988(4)	1987(3)		1988(3)	1988(3)		1988(3)	1988(4)	
P		1989(3)	1988(2)	1989(4)					1989(4)		1989(2)				1989(3)
T			1988(4)	1990(4)							1990(1)				1990(4)
P	1990(2)		1990(1)		1990(4)		1990(2)	1990(1)			1990(4)				
T	1991(4)	1991(2)	1990(4)		1991(4)		1990(4)	1990(3)			1991(4)				
P											1992(2)			1991(1)	
T									1993(2)		1993(1)			1991(4)	
P					1994(4)	1994(4)	1994(3)	1994(1)	1994(4)	1995(1)	1995(2)		1994(3)	1994(3)	
T					1995(2)	1995(3)		1995(4)	1995(3)						
P		1997(4)			1996(2)	1996(1)		1996(2)							
T		1998(3)					1997(1)			1997(1)	1996(3)		1996(3)	1998(3)	
P	1998(2)	1999(1)		1999(4)			1997(4)			1998(2)	1997(1)	1997(3)	1997(2)	1998(4)	1997(4)
T	2000(1)	2000(4)		2000(3)	1999(1)	1998(2)	1998(3)	1998(4)		1998(3)	1998(3)	1998(3)	1998(3)	2000(2)	1998(3)
P			2000(1)		2000(1)	2001(1)	1999(2)	2000(4)	2000(4)		2001(4)	1999(2)			2000(1)
T			2001(1)		2001(3)	2001(2)	2001(3)	2001(2)	2001(3)		2002(2)	2002(2)			2000(4)

P = Peak, T = Trough
NZ = aggregate New Zealand activity, ND = Northland, AK = Auckland, WK = Waikato, BP = Bay of Plenty, GS = Gisborne, HB = Hawkes Bay, TA = Taranaki, MW = Manawatu/Wanganui, WG = Wellington, NM = Nelson/Marlborough, WC = West Coast, CA = Canterbury, OT = Otago, SD = Southland

Table 3 Classical Turning Points for Cycles in REINZ House Prices
NBER (Bry and Boschan) Method, 1981q1 to 2004q2

	ND	AK	WK	BP	GS	HB	TA	MW	WG	NM	WC	CA	OT	SD	NZD
P	1981(2)		1981(2)												
T	1981(4)		1982(2)				1981(4)	1981(4)	1981(4)	1981(4)	1981(2)	1981(4)	1982(4)	1981(4)	1982(2)
P					1982(4)						1982(2)				
T				1983(2)	1984(4)	1983(2)					1983(2)				
P	1984(3)			1984(3)		1984(2)	1984(2)	1983(4)	1984(4)	1985(2)	1984(2)		1984(2)	1984(1)	
T				1985(2)		1985(2)	1986(4)	1985(2)	1985(2)	1986(2)	1986(1)		1985(2)		
P			1986(3)	1986(1)	1986(2)	1986(3)	1987(4)	1985(4)		1987(2)	1986(4)	1986(3)	1985(4)		
T	1988(1)		1987(2)	1986(4)	1987(2)	1987(2)	1988(4)	1987(4)		1988(2)	1988(2)	1987(2)	1986(4)		
P	1988(4)	1990(1)	1990(1)	1990(1)	1990(1)		1990(1)	1990(1)	1990(1)		1990(2)	1989(2)	1988(2)		1990(1)
T	1991(1)	1991(1)	1991(1)	1990(4)	1990(3)		1990(4)	1990(3)	1990(3)		1991(1)	1989(4)	1990(2)	1990(3)	1991(1)
P		1992(1)							1992(2)		1992(3)	1992(1)	1991(4)		
T		1993(3)							1992(4)		1993(2)	1993(1)	1992(4)		
P					1994(2)	1996(1)	1994(2)		1995(1)		1994(1)		1994(3)	1994(4)	
T					1995(1)		1995(2)		1995(3)		1994(4)		1995(2)	1996(4)	
P		1998(1)	1998(3)		1997(3)		1995(4)	1996(4)	1997(4)		1997(2)	1998(2)	1998(1)	1997(3)	
T		1998(3)			1998(3)	1998(4)	1997(1)	1998(3)	1998(4)		1998(1)	1998(4)	1998(3)	1998(2)	
P						1999(2)	1997(4)	1999(3)			1999(1)	1999(4)		1998(4)	
T			2000(4)			2000(1)	1998(2)	2000(2)			2000(1)			2000(4)	2000(2)
P		2001(1)			2000(1)		2000(2)	2001(1)	2000(2)	2000(4)					2000(4)
T		2001(3)			2001(3)		2001(2)	2003(1)	2001(3)	2001(4)		2001(2)			

P = Peak, T = Trough
NZ = aggregate New Zealand activity, ND = Northland, AK = Auckland, WK = Waikato, BP = Bay of Plenty, GS = Gisborne, HB = Hawkes Bay, TA = Taranaki, MW = Manawatu/Wanganui, WG = Wellington, NM = Nelson/Marlborough, WC = West Coast, CA = Canterbury, OT = Otago, SD = Southland

Table 4 Concordance Between Business Cycle Expansion and Contraction Phases for QVNZ and REINZ Regional House Price Data, 1981q1 to 2004q2

	Contemporaneous	QVNZ leads REINZ			REINZ leads QVNZ		
Region	**Concordance/ GMM T-stat**	**Conc**	**GMM T-stat**	**Qtrs lead**	**Conc**	**GMM T-stat**	**Qtrs lead**
Northland	0.74 (2.23**)	0.80	3.77***	3			
Auckland	0.74 (0.74)						
Waikato	0.77 (1.82*)						
Bay of Plenty	0.76 (2.00*)				0.78	2.45**	1
Gisborne	0.67 (2.03**)	0.68	2.56**	2			
Hawke's Bay	0.72 (2.39***)						
Taranaki	0.80 (5.54***)						
Manawatu	0.68 (2.03**)						
Wellington	0.73 (2.93***)						
Nelson	0.70 (0.87)				0.73	1.66**	4
West Coast	0.59 (1.04)						
Canterbury	0.66 (0.52)				0.74	1.72**	2
Otago	0.71 (2.21**)						
Southland	0.74 (3.92***)				0.78	4.98***	2
New Zealand	0.73 (0.81)						

The GMM test is the t-test on the coefficient C in the implicit equation
$dREINZHP_i(t)*dQVNZHP_i(t+k)-C=0$,
where the series have been de-meaned, and $REINZHP_i$ and $QVNZHP_i$ are the binary real house price series for region i (or New Zealand). The GMM estimation was conducted using the Bartlett kernel with a fixed bandwidth of 4. The null hypothesis of no concordance is rejected for one-tail tests, if the test result is greater than critical values of 2.37 (1 percent level, denoted ***), 1.66 (5 percent level, denoted **), and 1.29 (10 percent level, denoted *)
For the lead/lag relationships, only the highest concordances, significant at 5 percent levels or better, are presented.

Table 5 Durations and Amplitudes of Completed Expansions and Contractions
QVNZ Regional House Prices, 1981q1 to 2004q2

Region	Duration†				Average Amplitude (% change)			
	Expansion		Contraction		Expansion	Contraction	Expansion	Contraction
	No.	Average	No.	Average			Per Quarter	
Northland	3	13	4	8.25	31.0	-14.0	2.84	-1.85
Auckland	4	13.3	5	4.40	27.4	-7.26	2.18	-1.84
Waikato	5	10.6	6	4.00	17.3	-6.05	2.13	-1.52
Bay of Plenty	4	12.0	5	5.20	23.1	-9.91	2.58	-2.16
Gisborne	5	7.00	6	7.00	24.6	-17.9	3.91	-3.35
Hawkes Bay	4	11.0	5	6.60	18.8	-10.3	1.96	-2.64
Taranaki	4	6.75	5	8.60	17.2	-15.0	2.94	-2.16
Manawatu/Wang.	4	8.50	5	6.8	13.1	-10.6	1.70	-2.11
Wellington	3	13.7	4	6.50	20.3	-5.87	1.38	-1.03
Nelson/Marlb.	3	12.7	4	7.00	18.6	-8.98	1.57	-3.04
West Coast	8	5.38	9	4.44	31.7	-20.0	7.62	-5.31
Canterbury	2	23.0	3	9.00	27.2	-8.49	1.51	-0.98
Otago	3	11	3	10	31.5	-15.3	3.56	-1.71
Southland	4	6.75	5	9.4	16.5	-18.7	5.05	-2.41
New Zealand	4	12.5	5	5.00	20.1	-5.29	1.8	-1.28
Average	4	11.05	5	6.94	22.7	-12.03	2.92	-2.29

† Durations are expressed in quarters

Table 6 Durations and Amplitudes of Completed Expansions and Contractions
REINZ Regional House Prices, 1981q1 to 2004q2

Region	Duration†				Average Amplitude (% change)			
	Expansion		Contraction		Expansion	Contraction	Expansion	Contraction
	No.	Average	No.	Average			Per Quarter	
Northland	2	7.00	3	8.33	15.85	-13.33	1.74	-2.51
Auckland	3	10.67	4	3.50	22.17	-4.44	1.78	-1.56
Waikato	3	19.33	4	5.00	36.60	-9.85	2.08	-2.27
Bay of Plenty	3	7.00	3	3.00	12.53	-7.27	2.08	-2.42
Gisborne	5	9.60	6	4.50	28.70	-13.85	3.11	-3.20
Hawkes Bay	4	11.50	4	5.25	31.50	-7.15	2.97	-2.03
Taranaki	7	6.57	7	4.57	14.97	-8.17	2.13	-1.66
Manawatu/Wang.	6	8.50	6	5.67	12.06	-6.46	1.89	-1.47
Wellington	6	10.33	6	2.83	19.22	-4.25	1.82	-1.68
Nelson/Marlb.	3	22.67	3	4.00	30.78	-6.89	1.63	-1.72
West Coast	8	5.25	8	4.13	20.21	-14.28	4.64	-3.52
Canterbury	5	12.20	5	3.40	17.26	-4.64	1.33	-1.43
Otago	6	6.33	6	4.17	13.66	-7.39	2.41	-2.01
Southland	4	7.75	4	11.25	12.26	-16.44	1.91	-2.06
New Zealand	2	34.00	2	3.00	49.32	-4.41	1.46	-1.31
Average	4.5	11.91	4.7	4.84	22.47	-8.59	2.20	-2.06

† Durations are expressed in quarters

Table 7 Formal Tests on the Nature of Expansions and Contractions in QVNZ Regional House Prices, 1981q1 to 2004q2

	Expansions		Contractions	
	Brain-Shapiro	Spearman	Brain-Shapiro	Spearman
Northland	0.49	0.50	0.47	0.40
Auckland	-0.05	1.00*	-0.07	0.74*
Waikato	1.63	0.87*	-0.71	0.55
Bay of Plenty	1.12	0.95*	1.72	0.52
Gisborne	0.89	0.45	0.73	0.60
Hawke's Bay	0.42	0.80	0.75	0.36
Taranaki	1.07	0.63	0.41	0.90*
Manawatu-Wanganui	-0.56	0.80	0.23	0.97*
Wellington	-0.16	1.00*	1.03	0.32
Nelson-Marlborough	0.58	1.00*	0.61	0.20
West Coast	1.37	0.69	0.18	0.42
Canterbury	--	--	-0.62	0.50
Otago	0.49	1.00*	0.30	1.00*
Southland	-0.68	0.80	0.44	0.90*
New Zealand	0.94	0.20	1.78	0.67
All Phases†	1.56	0.74*	-0.58	0.57*

Notes: The Brain-Shapiro statistic is used to examine duration dependence in regional business cycles. The null hypothesis of the Brain-Shapiro statistic is that the probability of terminating a phase (expansion or contraction) is independent of the length of time a series has been in that phase. An asterisk denotes that the null hypothesis is rejected (using a five percent critical value for a two-tailed test); any result greater than the critical value of 1.96 (in absolute value) indicates duration dependence in the series.

The Spearman rank correlation coefficient examines whether there is any relationship between duration and amplitude of a phase. The null hypothesis is no rank correlation between the amplitude of a phase and its duration. An asterisk denotes that the null hypothesis is rejected (using a one-tailed test) at the five percent level of significance, where the five percent critical value for significant correlations is given by $1.65/N^{1/2}$, N being the number of expansions or contractions in the sample period

† All phases denote tests conducted using sample period expansions and contractions for all 14 regions and New Zealand.

Table 8 Formal Tests on the Nature of Expansions and Contractions in REINZ Regional House Prices, 1981q1 to 2004q3

	Expansions		Contractions	
	Brain-Shapiro	Spearman	Brain-Shapiro	Spearman
Northland	--	--	-0.23	0.50
Auckland	--	1.00*	0.66	-0.32
Waikato	0.18	0.50	0.77	0.63
Bay of Plenty	0.38	1.00*	--	--
Gisborne	0.41	0.67	--	0.75*
Hawke's Bay	1.19	0.95*	1.30	-0.21
Taranaki	0.38	0.86*	0.51	0.78*
Manawatu-Wanganui	1.33	0.83*	-1.17	-0.21
Wellington	0.76	0.41	1.80	0.43
Nelson-Marlborough	0.36	1.00*	--	--
West Coast	1.11	0.05	1.86	0.56
Canterbury	-0.19	1.00*	0.84	0.95*
Otago	-0.90	0.58	0.23	-0.15
Southland	0.56	1.00*	0.57	0.32
New Zealand†	--	--	--	--
Combined phases	2.32*	0.42*	3.56*	0.10

Notes: The Brain-Shapiro statistic is used to examine duration dependence in regional business cycles. The null hypothesis of the Brain-Shapiro statistic is that the probability of terminating a phase (expansion or contraction) is independent of the length of time a series has been in that phase. An asterisk denotes that the null hypothesis is rejected (using a five percent critical value for a two-tailed test); any result greater than the critical value of 1.96 (in absolute value) indicates duration dependence in the series.

The Spearman rank correlation coefficient examines whether there is any relationship between duration and amplitude of a phase. The null hypothesis is no rank correlation between the amplitude of a phase and its duration. An asterisk denotes that the null hypothesis is rejected (using a one-tailed test) at the five percent level of significance, where the five percent critical value for significant correlations is given by $1.65/N^{1/2}$, N being the number of expansions or contractions in the sample period

† All phases denote tests conducted using sample period expansions and contractions for all 14 regions and New Zealand.

Table 9 QVNZ House Price Data, 1981q1 to 2004q2

Concordances of Regional House Prices with Regional Business Activity

Lags	NTH	AUK	WAI	BOP	GIS	HB	TAR	MAN	WEL	NEL	WC	CAN	OTA	STH
0	0.7	0.82	0.67	0.76	0.65	0.72	0.71	0.61	0.7	0.67	0.62	0.71	0.70	0.59
2	0.72	0.73	0.68	0.73	0.64	0.67	0.71	0.62	0.7	0.68	0.57	0.68	0.65	0.53
4	0.67	0.66	0.68	0.68	0.59	0.62	0.61	0.54	0.69	0.66	0.59	0.63	0.6	0.52
6	0.63	0.68	0.65	0.7	0.51	0.58	0.56	0.44	0.68	0.66	0.60	0.72	0.55	0.58
8	0.57	0.77	0.71	0.81	0.45	0.55	0.5	0.48	0.72	0.66	0.57	0.76	0.56	0.62
10	0.56	0.79	0.83	0.69	0.38	0.54	0.49	0.49	0.79	0.65	0.56	0.75	0.55	0.51
12	0.6	0.71	0.73	0.61	0.34	0.55	0.43	0.48	0.73	0.65	0.52	0.74	0.49	0.45

Concordances of Regional House Prices with National Business Activity

Lags	NTH	AUK	WAI	BOP	GIS	HB	TAR	MAN	WEL	NEL	WC	CAN	OTA	STH	NZD
0	0.66	0.76	0.69	0.73	0.59	0.7	0.6	0.63	0.67	0.71	0.63	0.7	0.65	0.55	0.72
2	0.65	0.73	0.73	0.71	0.53	0.63	0.57	0.62	0.66	0.71	0.58	0.67	0.62	0.52	0.7
4	0.62	0.72	0.7	0.66	0.5	0.58	0.49	0.57	0.66	0.63	0.51	0.64	0.57	0.49	0.67
6	0.63	0.77	0.69	0.66	0.47	0.58	0.5	0.56	0.65	0.64	0.57	0.68	0.58	0.48	0.69
8	0.62	0.84	0.76	0.77	0.5	0.59	0.49	0.57	0.69	0.64	0.58	0.67	0.59	0.47	0.78
10	0.63	0.83	0.83	0.76	0.52	0.58	0.52	0.58	0.7	0.63	0.55	0.67	0.58	0.4	0.8
12	0.65	0.78	0.76	0.68	0.56	0.6	0.49	0.57	0.74	0.62	0.59	0.66	0.57	0.41	0.7

Table 10 REINZ House Price Data, 1981q1 to 2004q2

Concordances of Regional House Prices with Regional Business Activity

Lags	NTH	AUK	WAI	BOP	GIS	HB	TAR	MAN	WEL	NEL	WC	CAN	OTA	STH
0	0.79	0.82	0.71	0.77	0.66	0.7	0.64	0.56	0.71	0.8	0.63	0.71	0.61	0.56
2	0.74	0.77	0.71	0.76	0.63	0.65	0.67	0.58	0.68	0.82	0.58	0.77	0.66	0.55
4	0.73	0.7	0.81	0.71	0.58	0.62	0.62	0.54	0.70	0.83	0.66	0.77	0.68	0.57
6	0.73	0.74	0.81	0.68	0.52	0.68	0.52	0.53	0.72	0.83	0.72	0.74	0.65	0.63
8	0.74	0.8	0.8	0.77	0.49	0.65	0.47	0.59	0.76	0.83	0.66	0.78	0.62	0.66
10	0.79	0.85	0.82	0.83	0.55	0.64	0.55	0.51	0.8	0.82	0.63	0.8	0.63	0.63
12	0.78	0.79	0.74	0.73	0.56	0.63	0.59	0.4	0.7	0.87	0.6	0.79	0.57	0.52

Concordances of Regional House Prices with National Business Activity

Lags	NTH	AUK	WAI	BOP	GIS	HB	TAR	MAN	WEL	NEL	WC	CAN	OTA	STH	NZD
0	0.72	0.82	0.73	0.74	0.7	0.66	0.65	0.61	0.77	0.84	0.66	0.72	0.62	0.53	0.82
2	0.67	0.82	0.75	0.76	0.67	0.67	0.64	0.58	0.78	0.82	0.61	0.78	0.67	0.5	0.84
4	0.73	0.79	0.79	0.78	0.64	0.64	0.61	0.57	0.76	0.81	0.6	0.76	0.69	0.56	0.86
6	0.75	0.78	0.81	0.8	0.64	0.7	0.58	0.58	0.75	0.81	0.61	0.8	0.7	0.55	0.88
8	0.74	0.8	0.83	0.84	0.67	0.7	0.59	0.62	0.77	0.8	0.6	0.81	0.72	0.53	0.90
10	0.74	0.85	0.87	0.9	0.74	0.69	0.68	0.58	0.83	0.8	0.64	0.79	0.67	0.50	0.99
12	0.71	0.84	0.79	0.85	0.71	0.68	0.62	0.55	0.78	0.84	0.63	0.78	0.63	0.39	0.91

Table 11 Significance Tests for Concordances of Business Activity Leading QVNZ Regional House Prices, 1981q1 to 2004q2

(GMM t-statistics, number of lags in brackets)

Region	Regional Business Activity	National Business Activity
Northland	1.29 (0)*	0.66 (0)
Auckland	2.44 (0)***	1.65 (8)*
Waikato	2.45 (10)***	1.50 (8)*
Bay of Plenty	3.20 (8)***	4.15 (8)***
Gisborne	1.32 (0)*	1.52 (12)*
Hawkes Bay	4.58 (0)***	-0.18 (2)
Taranaki	3.56 (0)***	0.51 (0)
Manawatu	1.19 (2)	-0.12 (0)
Wellington	0.73 (8)	0.61 (10)
Nelson	-0.02 (2)	0.67 (0)
West Coast	0.67 (6)	0.50 (12)
Canterbury	1.93 (6)*	-0.002 (0)
Otago	2.30 (0)**	0.44 (8)
Southland	0.79 (6)	0.32 (0)
New Zealand		3.77 (8)***

The GMM test is the t-test on the coefficient C in the implicit equation $dQVNZHP_i(t)*dR_i(t+k)-C=0$, where the series have been de-meaned, $QVNZHP_i$ is the binary real house price series, and R_i is the binary business activity series for region i (or New Zealand). The GMM estimation was conducted using the Bartlett kernel with a fixed bandwidth of 4. The null hypothesis of no concordance is rejected for one-tail tests, if the test result is greater than critical values of 2.37 (1 percent level, denoted ***), 1.66 (5 percent level, denoted **), and 1.29 (10 percent level, denoted *)

Table 12 Significance Tests for Concordances of Business Activity Leading REINZ Regional House Prices, 1981q1 to 2004q2

(GMM t-statistics, number of lags in brackets)

Region	Regional Business Activity	National Business Activity
Northland	2.19 (0)**	1.25 (10)
Auckland	1.61(10)* 0.90(0)	0.33 (10)
Waikato	1.77 (10)**	1.90 (10)**
Bay of Plenty	3.39 (10)***	4.74 (10)***
Gisborne	0.53 (0)	0.44 (10)
Hawkes Bay	0.90 (0)	0.99 (8)
Taranaki	1.76 (2)**	0.77 (12)
Manawatu	0.47	0.77 (8)
Wellington	2.74 (10)***	5.66 (10)***
Nelson	2.43 (12)**	1.72 (12)**
West Coast	3.24 (6)***	2.26 (0)**
Canterbury	1.02 (12)	0.97 (8)
Otago	0.93 (4)	1.83 (8)**
Southland	3.30 (8)***	1.10 (6)
New Zealand		10.76 (10)***

The GMM test is the t-test on the coefficient C in the implicit equation $dREINZHP_i(t)*dR_i(t+k)-C=0$, where the series have been de-meaned, $REINZHP_i$ is the binary real house price series, and R_i is the binary business activity series for region i (or New Zealand). The GMM estimation was conducted using the Bartlett kernel with a fixed bandwidth of 4. The null hypothesis of no concordance is rejected for one-tail tests, if the test result is greater than critical values of 2.37 (1 percent level, denoted ***), 1.66 (5 percent level, denoted **), and 1.29 (10 percent level, denoted *)

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